

# An audit of lesser metatarsal osteotomy by capital proximal displacement (Weil osteotomy)

David R Tollafield, Consultant Podiatric Surgeon

## ABSTRACT

The post-operative predictability of the capital metatarsal displacement osteotomy has not been evaluated before by UK podiatrists. In this study 36 patients were evaluated using a score to rate the success of their surgery based on patient satisfaction scores. The scores correlated well ( $R^2=0.94$ ) with an American orthopaedic score rating for this audit.

The proximal displacement osteotomy (PDO), also known as the Weil osteotomy, has been shown to be successful in reducing some keratinous lesions. In this study, 36% cleared completely. The procedure also created elevation of toes in 22% of cases studied (anatomical disturbance and mechanical reasons for toe instability are considered the main cause of elevation).

Information provided by this audit study will contribute to evidence-based medicine in podiatry. The surgeon and patient will be guided by the likely outcome expected for this type of surgery. Data have been included for procedures undertaken with or without a concomitant first ray procedure. The foot surgeon must still consider the place of alternative procedures where failure of a PDO is likely to arise.

**KEY WORDS:** Audit, Weil osteotomy, metatarsalgia, lesser metatarsals, evidence-based medicine

## INTRODUCTION

Metatarsal osteotomies have been used for callus and metatarsalgia since the beginning of the century. Meissenbach carried out one of the first recorded elevatory osteotomies, documented in 1916.<sup>1</sup> Surgeons have used many variations since then where before excision of the metatarsal head alone was practised. Some surgeons leave their surgery to chance, following the principle that all the lesser metatarsals should be osteotomised together without any form of internal fixation.

The proximal displacement osteotomy (PDO) is poorly referred to in worldwide literature. It was first described in UK literature relatively recently,<sup>2,3</sup> although it has been used since the early 1990s in the UK and described at National Conferences. D R Bell was the first British podiatrist to describe the use of an obliquely set osteotomy through the metatarsal articular head in 1990 (Leicester) based on correspondence with L Scott-Weil (USA). L Barouk (France) described this same osteotomy for multiple metatarsal osteotomies in 1996 (Chester) at a later conference commending Scott-Weil for much of its design. The use and critical review of the PDO was presented by the author at the first Unified Conference in Bristol in 1998. Lesser metatarsal osteotomies carry risks of non-union and excessive elevation leading to transfer lesions.<sup>3</sup> Barouk discussed the elevated toe as an incidental problem that could be rectified by splinting the toe aggressively following surgery. The author felt however that the technique should ideally not necessitate splinting, particularly as the toe was often swollen and splinting might take a while to implement. The use of the McGlamry deglover created good tissue laxity at the metatarsophalangeal joint (MTPJ), but the instrument

was found to be destructive around the plantar plate causing lack of stability. The use of the PDO offers three main benefits:

1. It shortens the metatarsal
2. Plantar keratoma can be improved or eradicated
3. Digital malalignment may be corrected in the transverse plane.

In the case of flexible toe deformity, the proximal correction was considered preferable to digital surgery. Where the deformity is rigid then a digital arthroplasty or arthrodesis is still required. The procedure does not negate any system of stepwise surgical approach around the MTPJ.

Fundamental questions were asked to assist the hypothesis that the PDO provided either better or worse results than other osteotomies. Can the effectiveness of the PDO be measured? Why does the lesser toe resist correction? Does it help a plantar keratoma? Can such a study provide an estimate of the callus reduction rate? What is the long-term prospect following PDO osteotomies?

## METHOD & MATERIALS

The proximal displacement procedure is undertaken by forcing the incised metatarsal head proximally as shown in Figure 1. The redundant bone is trimmed and stabilised with internal fixation screw or wire. Eighty one per cent of the cases described in this paper used AO 2.0 screws in lengths from 12-16mm.

The proximal displacement osteotomy was used on 36 patients aged between 30 and 78, 79% of whom were female. Forty-seven metatarsals were involved. The longest period of follow up at the time of this report was 24 months, the shortest 6 months.

A system was designed to rate the effectiveness of the procedure adapted from the Kitaoka score system.<sup>4</sup> The

## Correspondence to:

Mr D R Tollafield, Consultant Podiatric Surgeon, BUPA Hospital Little Aston, Little Aston Hall Drive, Little Aston, Sutton Coldfield, West Midlands B74 3UP. E-mail david@poddoc.freereserve.co.uk

## Proximal displacement osteotomy (PDO)

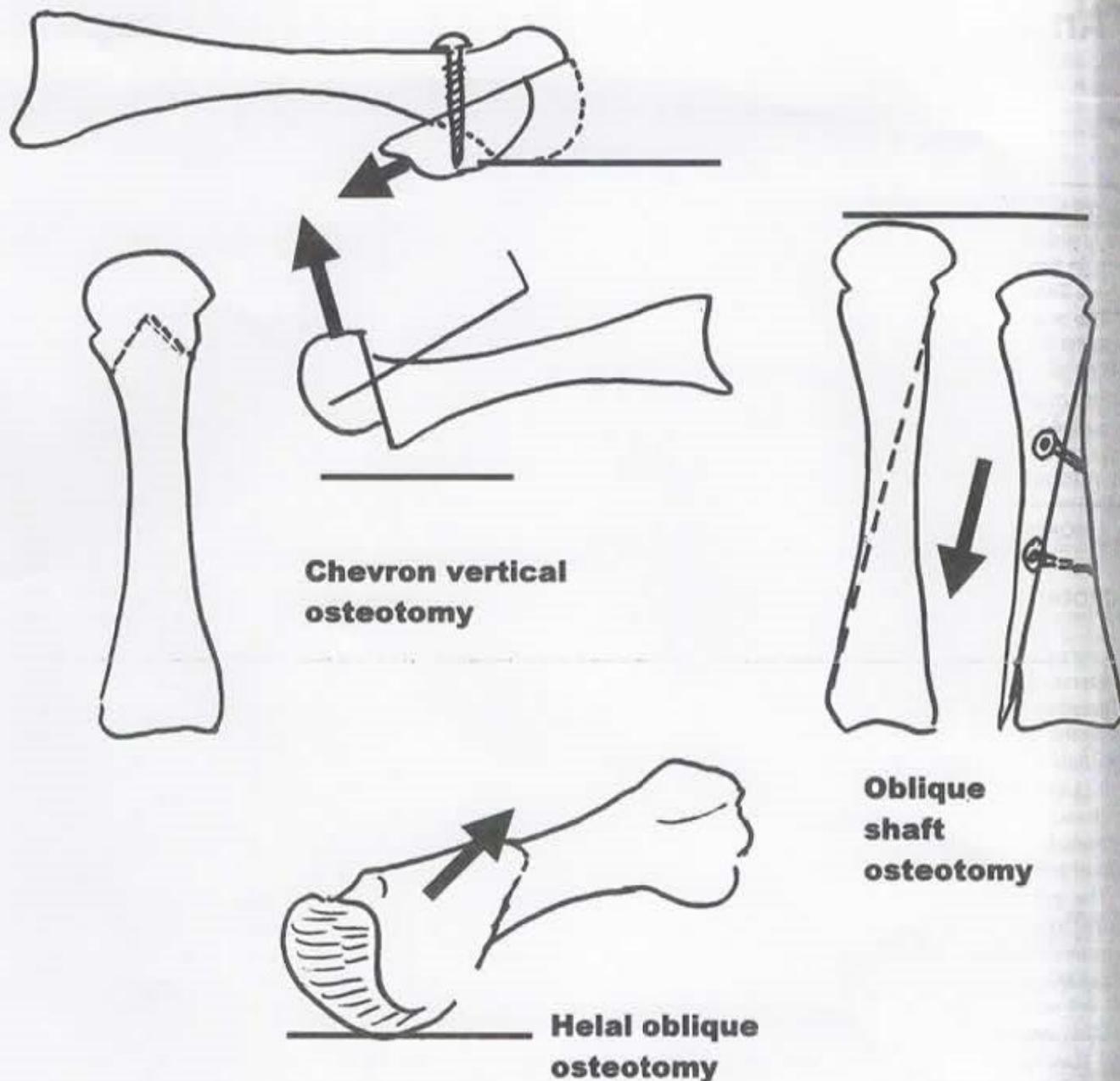


Figure 1. Four osteotomies: proximal displacement (capital), Chevron vertical (capital), oblique (shaft) and oblique capital after Hehal REF:. To avoid abnormal movement and non union, fixation is recommended to obtain best results.

PDO score		PDO score		PASCOM	
Patient analysis	29	Basic Surgery Quality	11	Patient Satisfaction score	100
Return to full mobility	10	No thickened scar line	4	Patient understanding	10
Return to occupation	5	No deformity, toe contacts ground fully	5	post operative events	30
All regular footwear can be worn	4	Fixation does not need to be removed	2	Management of foot problem	30
No pain or discomfort	5			Patient critical assessment	30
Complete lesion clearance	5				

Table 1. Scoring system used for MOFPL and Patient Satisfaction Questionnaire (PSQ) – Total of 100 points for four domains. The PDO score is divided into patient analysis (MOFPL) and basic surgery quality – Total of 40 points combined.

system adopted used a score of 0 to 40. This was known as the PDO score and was divided into a score for mobility-pain and a score for mobility-occupation-footwear-pain-lesion (MOFPL - 29 points). The second part of the PDO score related to the surgical improvement score (11 points possible) and was based on scar line thickness, deformity and fixation (removal required or not) (see Table 1).

### PODIATRIC AUDIT AND CLINICAL OUTCOME MEASUREMENT (PASCOM)

The overall audit process was facilitated by an electronic system based on a Microsoft Access database, which was developed for retrieval of all our surgical data. Patient satisfaction or PSQ is scored electronically after inputting patient responses. This audit tool measures the overall satisfaction of surgery and service delivery and is divided into four domains, collectively scored out of 100. The score is therefore representative of more than just the primary surgeon's performance. The four domains cover patient understanding, post-operative events, and management of foot problems and patient assessment. Two score systems were therefore used, the first the PDO score and the second the PSQ scores associated with PASCOM (Table 1).

Three criteria have been considered in this report from which evidence of effectiveness is described:

1. Level of discomfort from the problem after surgery
2. Effect on the lesion (if one was present beforehand)
3. The correction of the deformity.

## RESULTS

### Level of discomfort following osteotomy (6-24 months)

While 13 patients indicated some discomfort occasionally, 76% (25) of the patients studied felt better than before surgery. Four patients indicated pain at rest and four when walking or standing.

### Effect on the lesion

Twenty four per cent of patients in the study had no lesion under the metatarsal to start with. Of those patients who did have lesions, 36% were cleared completely, and a reduction in size and symptoms was shown in 32%. Therefore, 68% benefited from surgery. Sixteen per cent found no change in their lesion and 8% experienced transfer of their lesion to another metatarsal.

### Correction of deformity

One criterion associated with good outcome following surgery on a lesser metatarsal is that the digit will touch the ground after surgery. In 22% (7) of cases the digit did not touch the ground using the apex. In 47% of cases the digit lay flat but failed to touch the ground at rest, however it worked effectively for the propulsive period of gait. Six per cent demonstrated a better position i.e. in this case the toe was raised above 5mm but lay in a more satisfying position.

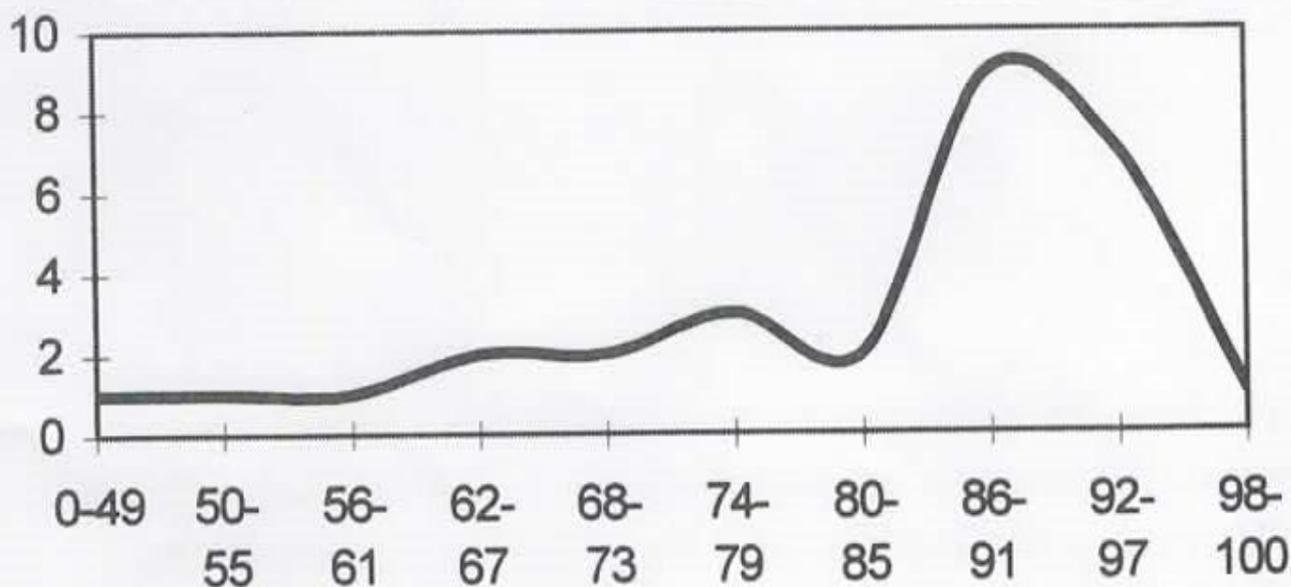


Figure 2. Frequency distribution for patient satisfaction data for the PDO. The range is from 20 (low score) to highest score of 100. The graph is skewed toward the higher end although a marginal bimodal peak is seen between 56-79.<sup>20</sup> is regarded as completely unsatisfactory while scores above 80 provide a good indication for success. (Data derived from PASCOM).

Three per cent (1) case had no change and 6% (2) cases felt that the toe was in a worse position (each of these patients scored 12 and 13 respectively on the PDO score of 40). Seventy per cent (23) of the procedures performed were the result of multiple procedures.

Some of the assessment inevitably included other surgery. In one case the patient had no less than four operations and, while she had improved, at the time of assessment a neuroma still had to be managed; this accounted for a PDO score of 12 and PSQ of 51, deemed to be the lowest in the study (Figure 2).

### Analysis of data

PDO scores were organised into three groups: single operation/metatarsal (A - 34%), double operation/two or more metatarsal osteotomies (B - 22%) and an osteotomy with a first ray procedure (C - 44%). There was no significance between the score values for each group using the U Mann-Whitney test (Table 1). PSQ scores (max. 100) correlated well with the effect of the PDO score (max 40)  $R^2 = 0.91$ . The section associated with MOFPL correlated even more strongly with surgical assessment ( $R^2=0.94$ ).

### DISCUSSION

This investigative work formed part of an audit review for a procedure not currently reported in UK literature. The analysis was undertaken using the author's earlier work on audit.<sup>5,6</sup>

A full audit on 36 cases was conducted up to the end of 1997. Two failures associated with toe contact following surgery gave concern. The PDO procedure was stopped while data were collected retrospectively to see if this was chance, or whether a fault lay in the surgical technique. Of 36 cases, only 33 cases had full data with clinical review, and 9% were lost to follow up.

The effect on reducing the size and, indeed, symptoms associated with keratoma was better than expected in this study compared with evidence gathered from other lesser metatarsal procedures (Table 2). The vertical displacement (chevron osteotomy) had a 9% transfer callus incidence ( $n = 45$ ) and 24% had residual pain.<sup>7</sup> DuVries's original condylectomy experienced transfers in 32% of cases.<sup>8</sup> Coughlin modified the condylectomy, and noted that only 13% experienced transfer and 5% failed to improve.<sup>8</sup> Despite

Helal's claim of 77% good results for keratoma, Winson's study used this technique in 94 cases and found 32% had significant problems.<sup>8,18</sup> This technique was recommended with central elevation of metatarsals 2-3-4. Winson found 50% of recurrence of lesions.<sup>8</sup>

Seventy per cent of the procedures in this study involved multiple cases. The fact that the second toe was commonly incriminated in forefoot pathology meant that the surgery was performed because of toe displacement or a long second metatarsal length problem.

Correction of the toe has not been well documented. While Barouk (cited earlier in the paper) suggested that toe elevation could be remedied by splinting, the mechanics of the MTPJ are very complex and the anatomical relationship with the plantar plate an important one. As this was a key concern leading to audit, some discussion is essential about the anatomy of the MTPJ and its mechanics.

Fortin *et al* proposed that a reduction of 48% of force is needed to disarticulate the lesser MTPJ if the collateral ligaments are sectioned.<sup>9</sup> Surgery will involve moving the head of the metatarsal proximally. The plantar plate and collateral ligaments that form a soft tissue box around the MTPJ are incised with surgery. Effective reduction of MTPJ deformity is less successful where the MTPJ is not appropriately released. A gap should be created to reduce MTPJ overlap with the base of the proximal phalanx. The attachment of the plate to the metatarsal is weak compared with the base of the proximal phalanx. McGlamry suggests releasing the metatarsal head to reduce the effect of capsulodesis that arises with some toe deformities.<sup>1</sup> The deglover instrument, in releasing the under-surface of the metatarsal, sweeps away the volar plate attachments. As the proximal attachments are weaker the structure is easy to section. The paradox that arises is created by overpull of the extensor tendon causing the toe to ride up.

While the deglover releases the joint usefully at surgery, within 4-6 weeks the toe is observed as abnormally raised after surgery. Once the plantar plate is sectioned then only 29% of force is required to dislocate the MTPJ. Furthermore, in the case history of a 6-year-old girl who sustained an hyperextension injury, the deforming force was found to disrupt the volar plate so that the extensor tendons maintained extension.<sup>10</sup>

To further confuse the point, with metatarsal condylectomies, the metatarsal must be exposed sufficiently to allow the head to be viewed for trimming.<sup>11</sup> Cases of elevation in condylectomy have not as yet been cited and there is no evidence to suggest that reduction of the plate attachment causes a deleterious effect.<sup>11</sup> The volar plate is cup shaped and provides a cushion to the joint. Indeed, Dr Valenti postulated in his UK lecture tour (c.1992) that disruption of the plate gave rise to plantar keratoma. No version of this work has as yet been recovered in the English language.

Joint stability is directly associated with the volar plate because it has an insertion of interosseous tendons, intermetatarsal ligaments and fibrous sheath of the flexor tendons as well as the collateral ligaments.<sup>12,13</sup> The possible reasons for disruption are plentiful when related to the anatomical structures, which have been surgically disturbed. Furthermore, the plantar fascia assists maintenance of tensile load when the toe is in propulsion, therefore this tension is inevitably affected as well.

**Table 2. Incidence of transfer lesions following metatarsal osteotomy/excision techniques. The results do not represent studies using the same methodology.**

Source	Procedure	%
Tollafeld	Proximal displacement	7
Dreben <sup>7</sup>	Chevron vertical displacement	9
Giannestras <sup>8</sup>	Z shortening/oblique shaft	10
DuVries <sup>8</sup>	Plantar Condylectomy	13
Pedowitz <sup>8</sup>	Distal oblique	25
Winson <sup>8</sup>	Distal oblique	32

The only surgical procedure to offer effective toe reduction with dislocation problems relates to basal hemiphalangectomy described initially by Gocht & DeBrunner (1927)<sup>10</sup>; even here only 60% of 86 cases had total relief. Girdlestone's flexor to extensor transfer may be used for toe instability.<sup>11</sup> Collateral ligament release and capsulotomy were performed in all of the cases. Even with this procedure, 46% were left with 7mm of elevation.<sup>11</sup>

From clinical experience and the limited research available on post lesser metatarsal surgery results, several important facts have been considered. Any reduction of MTPJ deformity will involve the plantar plate in some way. Repair of the dorsal sides (accessible by standard surgical exposure) of the capsule and ligaments does not constitute a full repair as the distal portion of the joint is not included.<sup>11</sup>

## CONCLUSION

When compared with other procedures, findings reported from this study suggest that the PDO (Weil osteotomy) fairs better or at least as well as other metatarsal osteotomies (Table 2).

The incidence and predictability of poor results have not been evaluated before. The author believes that the extensor mechanism will override the weakened flexor mechanism and cause an elevated toe for the following reasons:

1. The extensor hood and tendon, when unopposed by interosseous and lumbrical insertions to counter extension, will develop an overpull dorsally.<sup>1</sup> Surgical transfer of the flexor tendon will ameliorate some of this problem but will not cure the problem in all cases. The use of soft splinting is advised, but no substantial research has been developed to assist this theory over a long period.
2. Where pathology in the MTPJ is already poor and the intrinsic muscles weakened already, the toe will be less able to recover full function. The cut direction is almost certainly critical to the effect on the reciprocal soft tissue biomechanics following surgery.

The dorsal metatarsal bone is trimmed as redundant. This ultimately leads to bone haemorrhage within the capsule. In this study, the capsule was closed with one suture placed without tension to avoid pulling the toe proximally. Any haematoma associated with bone resection may lead to greater scarring in association with capsular damage, causing the toe to contract and elevate.

If the level of symptoms associated with plantar keratoma are severe enough then surgery for keratoma management by PDO may be justified if lesion transfer can be accepted (around 8%) with 68% overall improvement. Twenty four per cent of patients found some element of discomfort after 6 months, particularly where multiple procedures were utilised. The scores associated with single osteotomies and multiple procedures did not suggest a greater likelihood of poor outcome.

The PDO procedure should be used with caution. Utilising this procedure for flexible toe deformity and long metatarsals may not always be appropriate. Well-documented surgeries in the literature still suggest success from the vertical chevron osteotomy, Giannestras' shortening osteotomy, flexor to extensor transfer procedure and modified (Coughlin) condylecto-

my.<sup>11</sup> The use of the basal hemiphalangectomy has a place in surgery but should be used as a last resort. Opinions do vary between foot surgeons on the use of the basal hemiphalangectomy. Poor cosmetic appearance due to shortening and altered biomechanics makes it less acceptable, although there is a place for this operation with severe degenerative joint disease. The Schwartz osteotomy described as a double oblique lesser metatarsal osteotomy<sup>16</sup> offers similar security to the PDO-Weil osteotomy but as yet has not been audited robustly in the UK.

Female patients probably have higher expectations following toe surgery than males in order to accommodate a wider variety of footwear styles. Kilmartin is perfectly correct, lesser metatarsal surgery is unforgiving and more research is required.<sup>1</sup> T Glyn Thomas reminds us that within the foot, metatarsal osteotomies give rise to most foot litigation.<sup>17</sup>

## REFERENCES

1. McGlamry ED *et al* (Eds). *Comprehensive Textbook of Foot Surgery*. Vol 1. Baltimore: Williams & Wilkins, 1992; pp349-353.
2. Tollafeld D R, Kilmartin T E, Prior T D. *Clinical Skills in Treating the Foot*. Tollafeld DR, Merriman LM (Eds). Churchill-Livingstone, 1997; Chapter 14: 287-288.
3. Kilmartin T E. Distal lesser metatarsal osteotomies: a review of surgical techniques designed to avoid non-union and minimize transfer metatarsalgia. *The Foot* 1998; **8**: 186-196.
4. Kitaoka H B, Alexander I J, Adelaar R S, *et al*. Clinical rating systems for the Ankle-hindfoot, midfoot, hallux and lesser toes. *Foot & Ankle International*, 1994; **15**: 349-353.
5. Tollafeld, D R. Impact on Foot health - results of a five year study. *Journal of Podiatric Medicine* 1993; **48**: 89-92,96.
6. Tollafeld D R, Parmar D G. Setting standards for day care foot surgery. A quinquennial review. *British Journal of Podiatric Medicine & Surgery* 1994; **6**(1): 7-20.
7. Dreben S M, Noble P C, Hammerman S, *et al*. Metatarsal osteotomy for primary metatarsalgia, radiographic and pedobarographic study. *Foot and Ankle* 1989; **9**: 214-218.
8. Mann RA, Coughlin W. Keratotic disorders of the plantar skin. *Surgery of the Foot & Ankle*, Vol. 1. St Louis: Mosby, 1992; pp 423-425.
9. Fortin PT, Myerson MS. Second MTPJ instability. *Foot and Ankle International* 1995; **16**(5): 306-313.
10. Weinstein R N, Insler H P. Irreducible IP dislocation of the fourth toe. A case report. *Foot and Ankle International* 1994; **15**(11): 627-629.
11. Boberg JS. Plantar condylectomy of the intractable plantar keratoma. In *Reconstructive Surgery of the Foot and Leg Update*. Camasta, Vickers and Ruch (Eds). Tucker, Georgia: Podiatry Institute, 1994; Chapter 14: 66-68.
12. Johnston R B *et al*. The plantar plate of the lesser toes: An anatomical study in human cadavers. *Foot & Ankle International* 1994; **15**(5): 276-282.
13. Deland *et al*. Anatomy of the plantar plate and its attachments in the lesser metatarsal phalangeal joint. *Foot & Ankle International* 1995; **16**(8): 480-486.
14. Thompson FM, Deland J T. Flexor tendon transfer for MTP instability of the second toe. *Foot & Ankle* 1993; **14**(7): 385-388.
15. Coughlin MJ. Second metatarsophalangeal joint instability in the athlete. *Foot and Ankle* 1993; **14**(6): 309-319.
16. Schwartz, N. New procedure for stabilizing of lesser metatarsophalangeal joints: a preliminary study. *Journal of Foot & Ankle Surgery* 1997; **36**(3): 236-239.
17. T Glyn Thomas. Medical litigation and the foot. *The Foot* 1991; **1**: 3-5.
18. Idusay O, Kitaoka H B, Patzer G L. Oblique metatarsal osteotomy for intractable plantar keratosis. *Foot & Ankle International* 1998; **19**: 351-355.